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Plant Diseases Common, Destructive, Preventable in South Dakota (Revised)

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PLANT DISEASES

Common, Destructive, Preventable

in

SOUTH DAKOTA

PLANT DISEASE CONTROL

an integral part of

AGRICULTURAL PRODUCTION FOR VICTORY

Agricultural Experiment Station
South Dakota State College
Brookings, South Dakota

CONTENTS

COMMON DESTRUCTIVE PREVENTABLE DISEASES OF FIELD, GARDEN AND FRUIT CROPS AND TREES IN SOUTH DAKOTA

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Plant Diseases and Agricultural Production for Victory

Abundant agricultural production is a victory goal and in South Dakota is based on an abundance of feed, forage and cash field crops and an adequate home vegetable and fruit supply. On the other hand, soil conservation and the maintenance of South Dakota's agricultural productivity depends on a practice of moderate rather than wholesale over-cropping of cultivated land. Shortages of labor and machinery place a definite limit on the amount of really good farming that can be done in South Dakota for the duration of the war. One of the ways to insure maximum crop production from a minimum of planted acres is to avoid and prevent useless losses from plant diseases.

The 1942 season brought to attention an unusual number of plant diseases on both field and garden crops in South Dakota. In the eastern third of the state, diseases "took" as much barley, oats and wheat as was finally harvested. Farmers are in possession of the most heavily diseased seed lots of all small grain and corn that they have produced in at least ten years. Some barley seems unfit for feed. The potato crop suffered from the worst of all potato diseases, late blight, and seed stocks are now commonly infected by the late blight pathogen, so that another outbreak is imminent depending on the weather. The tomato crop, though probably finally adequate, was disappointing to say the least in both yield and quality. It seems ironical that such disappointing events accompanied an honest attempt at even more bountiful production than was achieved.

In most cases recognition in advance of the danger can lead to prevention of these and other similar plant disease losses at a time when they are particularly costly. The following list of plant diseases, their most distinguishing characteristics and their nature and control has been prepared for those who are engaged directly or indirectly in promoting agricultural production for victory in South Dakota. This is not in any sense a complete list of South Dakota plant diseases and the descriptions are not comprehensive. In general the common, recognizable, costly and controllable diseases are included. Certain limitations to control are pointed out and particular attention is directed to wartime shortages of fungicidal materials

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Fungicide Supplies Likely to be Limited During the Emergency

Mercury, copper and formaldehyde are the basic ingredients of many plant disease control materials. All of these are used in armament manufacture and by 1943 supplies for plant disease control may be limited. Sulfur and its derivatives will probably be available. Some substitutes may be available and their usability will be publicly announced when such becomes necessary. Among the materials of which a shortage may be expected are:

Copper carbonate for treating sorghum and wheat seed for smut.

Copper sprays and dusts.

Organic mercury dusts and wet treatments. These include:

Merko, Barbak and New Improved Semesan Jr. for treating seed corn.

New Improved Ceresan and Ceresan for treating cereals and sorghum seed for smut and other seed-borne diseases.

Semesan for treating vegetable seeds and bulbs.

Semesan Bel for treating potato seed pieces.

Mercuric chloride (corrosive sublimate) for treating potato seed pieces and general disinfection in grechouses, seedbeds, etc.

Formaldehyde for treating potato seed pieces and general disinfection in greenhouses, seedbeds, etc.

TREATMENT OF SMALL GRAIN SEED PLANTED IN 1943

The unusually heavy infection of wheat and barley grains by the scab fungus, of barley by the spot blotch fungus, and the very unfavorable conditions for timely and adequate harvesting of all small grains in 1942, have all contributed to make the small grain seed for 1943 the poorest available to South Dakota farmers for probably at least ten years.

The scab fungus on wheat and barley can definitely kill the germinating seed; it causes some seedling blight and "foot rot". The spot blotch fungus on the glumes of barley seed causes some seedling blight and much foot and root rot. Much small grain seed, including oats, was from poorly-made shocks in which before threshing there was "musty" grain and from which was threshed grain which heated and perhaps molded in the bin. Even though usually harmless, the molds on musty grain, because of their great abundance and the lack of vigor in the seed on which they occur, very often rot the seed during the germination process.

Unquestionably the cleaning, germination testing and treatment with a suitable fungicide of all small grain seed in the eastern half of South Dakota is a major small grain disease control necessity and would do much to help achieve agricultural production goals set for 1943. All the New Improved Ceresan or copper carbonate (for wheat) used in treating wheat, barley, oats and even flax seed this spring will be a good investment of those materials, probably even at a minor sacrifice by some war industry.

DISTINGUISHING CHARACTERISTICS OF STEM RUST AND THE LEAF RUSTS OF SMALL GRAINS

(Microscopic characters have not been included)

Stem rust	Leaf rust
Location on plant	
Primarily (not entirely) on stem and leaf sheath, often abundant near nodes.	Primarily on leaf blade and leaf sheath.
Red stage	
Spore mass brick red	Spore mass orange red.
Postules irregularly long, linear, large; epidermis of plant torn, turned back, flaky at edge of pustule.	Pustules short, oval or nearly round, small, regular; small hole in epidermis of plant.
Pustules usually broken through on both surfaces of leaf or leaf sheath.	Pustules usually broken through on only one leaf surface, predominantly the upper.
Black stage	
Displaces red stage in same pustules.	Forms in area around red pustle; red stage is not displaced.
Therefore black stage is in open pustle, with epidermis torn back, as was red stage.	Black stage remains covered by shiny epidermis.

BARLEY

Barley is the most afflicted of all the small grains with disease; in fact where the climate is favorable for corn, barley diseases are the limiting factors in satisfactory barley production and use. Fortunately the climate north and west of the corn belt is not quite so favorable for barley diseases, and in that area diseases ordinarily need not discourage barley production. In 1943, the barley crop in eastern South Dakota was cut in half by diseases. Two were particularly destructive; spot blotch, which reduced the yield so drastically by destroying the leaves, and scab, which has caused some feeding problems.

1. Scab

"Scabbed" barley is characterized by shrivelled kernels, which while the head is green appear brown, later are usually salmon yellow in color on heads or in the bin. Usually all the kernels of a spikelet are infected (one in Spartan, three in six-row barley), and frequently several adjacent spikelets in the head, on spike. Kernels in late stages of deterioration often are covered at the base with salmon to reddish-colored incrustation, which contains spores ("seeds") of the causal fungus.

The fungus attacks all the cereal crops, including wheat, barley, rye and oats, and corn, probably sorghum. It overwinters profusely on corn stalks which are the commonest source of infective material for barley grown in the corn belt, particularly that grown on corn stalk land.

Abundant moisture and humidity with moderate temperature favor the development of the disease. Such conditions in themselves are favorable for the development of the scab fungus, and also result in rank straw growth which under such conditions makes a virtual damp chamber of the air adjacent to the soil in small grain fields. An abundant supply of overwintered infected material within or immediately adjacent to a field of barley is all that is needed for profuse infection. The corn stalks underneath a heavy growth of barley on corn land are in effect such a reservoir of the scab fungus. On the other hand, corn stalk-borne spores of the scab fungus apparently are not carried very far in quantity, probably not over a few rods.

Planted infected kernels probably have very little to do with the amount of scab infection on the subsequent crop, since the fungus does not grow upward through the plant. Such infected kernels may be killed by the scab fungus during germination or if not killed, the seedlings developed from them may "blight" and die or be stunte

An excess of 5 to 10 percent scabbed kernels in barley usually makes it unfit for hog feed. More than 4 percent disqualifies it for malting purposes, and to grade "no. 1 malting", the "blight" content must be under 2 percent.

Control: There is an abundance of scabbed kernels in eastern South Dakota barley this year. Careful screening and fanning may remove some of the shrivelled, infected kernels. Treatment of scabbed barley with an organic mercury dust (New Improved Ceresan), 1/2 oz. per bushel, will certainly result in more uniform stands of healthy seedlings in 1943. Seed treatment will not insure freedom of the crop from scab if it is grown on or adjacent to corn stalk land. If the farming plan calls for some small grain on plowed land, then that land might be allotted to barley, and oats and flax planted on the corn stalk land. Oats are not very susceptible to the scab fungus, and the new leaf rust-resistant oat varieties (Boone, Tama, Vicland, Vikota) are likely to yield as much or more just as satisfactory feed per acre than barley in eastern South Dakota.

Dilution of infected barley with other feeds may enable hogs to utilize scabbed barley. Cattle usually eat it with safety and it may be safely included as a part of the sheep and poultry ration.

2. Spot blotch

The most conspicuous symptom of spot blotch is a profusion of dark brown-centered, indefinite-edged spots, half an inch long and an eighth inch wide, at about heading time. When the disease becomes severe, the spots may nearly cover the leaf and thus kill it. The glumes may be streaked and often the basal portion of the kernel is darkened by the fungus. Shrivelling is not as common as with scab. When infected kernels are planted, very severe foot and root rot may result. If so, the first leaf may turn yellow and die and the lower portions of the stem and the lower leaf sheaths become brown.

The causal fungus occurs profusely on any cereal refuse on or in soil. Its spores are spread long distances in the air.

Control: Bad as was barley scab, spot blotch was by far the worst and most widespread disease of barley in the eastern half of South Dakota in 1942. It was mainly responsible for the disappointing yield of barley and is almost universally present on barley seed. It does not so often kill the germinating seed, but causes much more foot rot and root rot than the scab fungus. Its presence on seed, whether the scab fungus is present or not, is the prime reason for treating all 1943 barley seed with New Improved Ceresan, 1/2 oz. per bushel.

In view of the universal presence of the causal fungus and wide spread of its spores, there is no possible control of the later phase of the disease on the heading plant. There are no suitable resistant varieties.

3. Covered Smut

Covered smut of barley is characterized by black sooty degeneration of all the kernels of all the heads of an infected plant. The black spore mass is covered by a membrane and remains intact until mechanically broken, usually by harvest operations, when the tiny black spores are disseminated and some are deposited on the surface of normal grain. There they remain to germinate with the seed and inconspicuously infect all parts of the growing plant. Black spore masses displace the kernels of all heads on plants thus infected. The damage to the crop is in direct proportion to the number of heads destroyed.

Control: Kill the spores adhering to the seed by treating before planting with an organic mercury dust, New Improved Ceresan, 1/2 oz. per bushel as per directions on the carton. Covered smut can be disseminated in a thresher.

4. Loose Smut

Barley loose smut is not covered by a membrane; the black sooty degeneration engulfs the entire head excluding the rachis. The black spore mass is disseminated, principally by wind, at about the time the barley plant blossoms, or a bit later. Some of the spores come to rest on developing normal kernels, germinate, and grow into them before maturity and without visible external effect. When an infected seed germinates, the fungus also resumes growth and finally destroys every head formed on the infected plant.

Control: Since infection by certain strains of the barley loose smut fungus does not extend deeply into the seed, seed treatment as for covered smut sometimes also controls loose smut, namely, an organic mercury dust (New Improved Ceresan), 1/2 oz. per bushel. Other strains, which grow deep into the embryo ("germ") can be controlled only by the hot water treatment, about which the county agent or the experiment station plant pathologist should be consulted. The correct procedure, therefore, if barley has been heavily smutted (a considerable amount in east-central South Dakota

has), is to treat the seed with an organic mercury dust; if a noticeable amount of smut still persists in the crop, see your county agent and consult your experiment station plant pathologist about the hot water treatment.

5. Rusts

Rusts have in recent years not been a major factor in barley production in South Dakota. Barley is parasitized by the same races of stem rust which occur commonly on wheat in South Dakota. It has its own leaf rust. Both have first a red stage, later a black stage. (See discussion of distinguishing characters of stem rust and leaf rusts on page 5.)

Control: Plant early. Every additional week toward maturity lessens the likelihood of rust damage. All of the barley varieties available for South Dakota are susceptible to both stem rust and leaf rust.

6. There are several other common barley diseases which take a certain toll, but for practical purposes they are at present unpreventable and are not enumerated here.

WHEAT

1. Scab

In its most conspicuous form, scab is recognized by the immature ripening of one or more spikelets of the head any time after flowering. At the dough stage, the pale yellow color of such infected spikelets is in sharp contrast with the healthy green of the rest of the head. In addition, there sometimes is a pink incrustation at the bases of infected spikelets which contains the spores of the causal fungus. Kernels of severely affected spikelets have a grayish-white or salmon to reddish color, are badly shrunken and wrinkled, and have a noticeably rough, flaky seed coat. In late summer, the heads attacked earlier become speckled with tiny, blue-black particles. Sometimes entire heads are attacked, as was frequently the case in eastern South Dakota in 1942.

Infected kernels may either fail to germinate, be killed in germination or produce plants which may soon die or become wilted and stunted.

For a discussion of the relation of this disease to corn stalk land see "scab" under "barley".

Control: Of the small grains, wheat is the most susceptible to scab. Some varieties are worse than others, but all are highly susceptible. On the basis of disease relationships, wheat, because of scab, is not a corn belt crop. However, in 1942 there was considerable scab on wheat even in north central South Dakota. Screening and fanning and then treating the seed with New Improved Ceresan, 1/2 oz. per bushel, or copper carbonate, 2 oz. per bushel, as for covered smut control, will result in more uniform stands of more vigorous plants from scabbed seed. If the farmer is determined to grow wheat in extreme eastern South Dakota, then the suggestions for seeding on other than corn land are the same as for barley. If there is difficulty in feeding scabbed wheat to hogs, then the feeding suggestions are likewise the same as for barley.

2. Rusts

There are two common wheat rusts in South Dakota, stem rust and leaf rust, both of which have first a red stage, later a black stage. (See discussion of distinguishing characters of stem rust and leaf rusts on page 5.)

Control: In 1941 and 1942, leaf rust of wheat was so severe that Thatcher, which displaced Ceres in Eastern South Dakota after the stem rust outbreaks in 1935 and 1937, was distinctly an inferior wheat, especially in 1942, when it was also unusually susceptible to the scab fungus. Pilot and Rival, although not as resistant to stem rust as Thatcher, have been superior to Thatcher in 1941 and 1942 because of their degree of resistance to leaf rust.

The following table lists the common varieties of spring wheat and their susceptibility or resistance to stem rust and leaf rust.

Variety	Resistance or Susceptibility to: Stem Rust	Leaf Rust
Thatcher	Very resistant	Very susceptible
Ceres	Susceptible	Susceptible
Pilot	Resistant	Resistant
Rival	Resistant	Resistant
Reward	Very susceptible	Very susceptible
Marquis	Very susceptible	Very susceptible
Burbank (Quality)	Very susceptible	Very susceptible
Mindum	*Resistant	Resistant
Kubanka	*Resistant	Resistant
Red durum (Pentad)	Very resistant	Very resistant

*Mindum and Kubanka were infected with stem rust at Brookings in 1941. According to the Federal Rust Laboratory at St. Paul, race 17 is now the most common race of stem rust in the wheat belt. Race 17 rusts durum wheats. Dr. E. C. Stakman points out that if we have a serious stem rust out-break, durum wheats may be damaged more than in past years.

Plant early. Every additional week toward maturity lessens likelihood of rust damage.

Barberry eradication is a constructive enterprise insuring the freedom from local beginnings of stem rust outbreaks and the permanence of rust-resistant varieties developed by the plant breeder. Barberry eradication and the small-grain breeding program of the South Dakota Agricultural Experiment Station and the U. S. Department of Agriculture are stabilizing factors in South Dakota's cereal production capacity.

3. Covered Smut

Bunt, covered or stinking smut of wheat is apparently again becoming common in durum and Reward wheats in the South Dakota spring wheat area. The following communities shipped "smutty" wheat to Minneapolis in 1941: Groton, Britton, Willow Lake Florence, Kranzberg, Rauville, Watertown, Waverly. Considerable smutty wheat came from this same territory and from Ipswich in 1942. This smut is characterized by black socty degeneration of all the kernels of all the heads of an infected plant. The black spore mass is covered by a gray membrane and remains intact until mechanically broken, usually by harvest operations, when the tiny spores are disseminated and some are deposited on the surface of normal kernels. There they remain to germinate with the seed and inconspicuously infect all parts of the growing plant. Black spore masses displace the kernels of all heads on plants thus infected. The damage to the crop is a reduction in yield and the undesirable smell imparted to the mass of grain, which is discounted by the buyer.

Control: Kill the spores adhering to the seed by treating with a suitable disinfectant. An organic mercury dust, New Improved Ceresan, 1/2 oz. per bushel, is the most commonly used and recommended treatment. Copper carbonate, 3 oz. per bushel, well agitated with the seed to assure uniform coverage, is also effective. Covered smut can be disseminated in a thresher.

4. Loose Smut

Loose smut is, as the name indicates, not covered in the infected heads and is characterized by a black sooty disintegration of the entire wheat head excluding the rachis. The black spore mass is disseminated principally by wind at about the time the wheat blossoms, leaving only the unadorned rachis of the smutted head. Some of the spores come to rest on developing normal kernels, germinate and grow into them immediately without destroying them. Hence the fungus over-winters inside the seed, which bears no external evidence of infection. When an infected seed germinates, the fungus resumes inconspicuous growth with the plant throughout the season and infects and destroys every head formed.

Control: The loose smut fungus can be killed only one way: by heating the seed which harbors it internally. This is accomplished by immersing and holding the seed in water hot enough to kill the smut fungus but not the seed. Obviously the process is difficult and tedious; in fact, it is desirable to treat only enough seed to grow clean seed for the crop two years hence. Fortunately, loose smut is not prevalent on spring wheat in South Dakota. Anyone having it might do well to sell his seed stock and buy seed from a neighbor or Crop Improvement Association member known to have a smut-free seed stock. Should it become necessary to attempt a hot water treatment of wheat seed, consult the county agent or the experiment station plant pathologist.

5. Black Chaff

As the name implies, this disease occurs chiefly on the chaff or outer glumes and can be recognized as long, dark, more or less sunken stripes or spots, as a rule more abundant and noticeable on the upper than on the lower half of the glume. The inner surface of diseased glumes is brown or black spotted and awns of awned varieties are often brownish, especially at the base. In moist weather yellow beads of ooze occur on the surface of the black spots, which upon drying appear as small yellowish shiny scales.

On the stem the disease occurs as watersoaked or brown to black stripes, frequently just below the head. On leaves and sheaths it appears as yellow or translucent stripes.

Control: Black chaff is not controllable. Although its importance is probably greater than ordinarily realized, it does not seem to be as harmful as scab or the rusts. It is included here because it occurs so commonly on Rival wheat that in some instances Rival is recognizable by the presence on it of black chaff.

6. There are several other common wheat diseases which take a certain toll but for practical purposes they are at present unpreventable and are not enumerated here.

OATS

Of the small grains, oats are least afflicted with serious diseases. This relative freedom from disease doubtless accounts for their acceptance as a feed crop in the corn belt despite traditional lower average feed yields per acre than from barley. Two destructive diseases have been common on oats in recent years, namely, crown (leaf) rust and smut. In eastern South Dakota crown rust literally cut the

oat yield in half in 1941 and thirty to forty per cent in 1942. So many oat leaves were destroyed that the stems were very weak and the plants "ripened" prematurely and lodged. Yields and quality were disappointingly low in the face of adequate moisture and lack of extremely hot weather.

1. Crown Rust

Crown rust is the leaf rust of oats. (See general discussion of distinctive characteristics of stem rust and leaf rusts on page 5.)

Control: The control of crown rust lies in the use of a resistant variety. Such stem rust-resistant varieties as Richland and Miomark are extremely susceptible to crown rust. Stem rust resistant, crown rust resistant and smut resistant varieties are now available. They are: Vikota, Boone, Tama, and Vicland. Vikota has been released to Crop Improvement Associations by the South Dakota Agricultural Experiment Station. Boone and Tama are available in quantities in Iowa, and Vicland in Wisconsi The buckthorn is the alternate host of crown rust of oats. Extensive hedges of it sometimes are the source of severe early spring outbreaks in adjacent or nearby oat fields.

The resistance or susceptibility of available oat varieties to stem rust, crown rust, and smut is as recorded in the following table.

	Resistance or susceptibility to:		
Variety	Stem Rust	Crown Rust	Smut
Richland	Highly resistant	Very susceptible	Very susceptible
Gopher	Susceptible	Very susceptible	Susceptible
Miomark	Highly resistant	Extremely susceptible	Highly resistant
Nakota	Highly resistant	Extremely susceptible	Highly resistant
Iogold	Highly resistant	Very susceptible	Susceptible
Iowar	Very susceptible	Very susceptible	Very susceptible
Swedish Select	Susceptible (?)*	Very susceptible	Susceptible
Kherson	Susceptible (?)*	Very susceptible	Susceptible
Brunker	Very susceptible	Very susceptible	Very susceptible
Early Burt	Very susceptible	Very susceptible	Very susceptible
Rainbow	Resistant	Resistant	Susceptible
Vikota	Highly resistant	Highly resistant	Highly resistant
Boone	Highly resistant	Highly resistant	Highly resistant
Tama	Highly resistant	Highly resistant	Highly resistant
Vicland	Highly resistant	Highly resistant	Highly resistant

*Swedish Select and Kherson are varieties containing many lines.

The creation of these oat varieties has largely overcome all the major disease hazards of a cereal crop for the first time. Oats now definitely assumes its place as a dependable feed crop in grasshopper-free areas in eastern South Dakota.

2. Stem Rust

In recent years, stem rust has not been common on oats in South Dakota. (See general discussion of distinctive characteristics of stem rust and leaf rusts on page 5.) Richland, Miomark and Iogold are highly resistant. Gopher is susceptible but early, and thereby seems to escape infection. Eradication of the common barberry from South Dakota doubtless has contributed to lack of outbreaks in time to affect susceptible oats.

3. Smut

Smut is common on susceptible oats in South Dakota. All oats smut develops the same as covered smut of wheat or barley.

Control: Since the smut is carried on the surface of the kernel and hull, effective control is by an organic mercury seed surface dust disinfectant such as New Improved Ceresan, 1/2 oz. per bushel, applied as per directions on the carton. The Vikota, Boone, Tama, Vicland, Miomark, and Nakota varieties are highly resistant to smut.

4. "Moldy" Seed

While germinating oat seed is less likely to be damaged by seed-borne or even soil-borne molds than are wheat and barley, there is considerable "musty" oat seed this spring which may also be a bit weak in germination. Treatment of oat seed, though not as urgent as for barley and wheat, may in many cases improve seedling stand and vigor in 1943.

RYE

None of the diseases occurring on rye in South Dakota can be actively controlled by the grower at present. Ergot, however, is worthy of attention. Ergot is characterized by the long hard black mass protruding from the floret from the region where the kernel, which it replaces, should have been. Ergot may be toxic when eaten by animals frequently and in large quantities. It can be removed by screening and fanning the grain before feeding. Cleaning the seed before planting will not entirely control but may reduce the amount of ergot in the crop. Rye ergot contains a valuable drug, ergosterol, of which our foreign supply is somewhat limited. Doubtless there is greater possibility of a market now than during peace time, but it is by no means assured! For information regarding a market, the Pharmacy Department, Agricultural Experiment Station, Brookings, South Dakota, may be consulted. There is no market for other than rye ergot.

FLAX

1. Rust

Flax rust is characterized by first open red pustules full of spores similar to those on small grain, except round and larger and lighter colored. Later on the stems there occurs, usually around the red pustule, a shiny black swollen area, sometimes entirely around the stem. On larger stems this black area may develop in the absence of a red pustule. Defoliation, weakening of the stem and eventually reduced yields are the final results of rust.

The rust fungus overwinters only in the black stage on flax straw. The spores formed on this black stage in the spring are of such a nature that they probably are not carried far in a live state. They infect the growing flax crop and thus initiate the production of the first red pustules. The spores in these pustules are capable of considerable spread and of infecting other growing flax plants.

Control: Flax rust has become so prevalent in extreme northeastern South Dakota, as well as in the Red River valley of North Dakota and Minnesota, that extreme measures may be justified in attempting to moderate the ravages of the disease. Presumably some spores may remain in the trash in seed. Cleaning and then treating the seed with New Improved Ceresan, 1/2 oz. per bushel, therefore is a rust control measure, though a minor one at best.

Since the rust fungus overwinters on flax straw and stubble, and since the spores from this straw and stubble presumably do not migrate far, a thorough job of turning under flax stubble and utilizing flax straw before May 1 may be a sound flax rust control procedure. Flax straw apparently has feed value and its organic matter might be a valuable amendment to South Dakota soils. There is the additional possibility of selling flax straw if a really suitable market exists. Although as a farming practice the burning of rusted flax strawpiles is a waste of feed and organic matter, this method of disposal certainly would eliminate overwintering rust, provided the burning was complete.

In North Dakota, the Viking variety has been distributed to meet the rust problem. In South Dakota, this variety has been injured more by the Pasmo disease than Redwing and Bison appear to have been injured by rust.

2. Pasmo

This disease is primarily a leaf spot, but in advanced stages on susceptible varieties at harvest time results in a distinct browning of the entire crop, somewhat worse in small areas at first. The individual leaf spots are first yellow green, later brown. Stem spots are likewise first yellow green, and when numerous, result in a mottled light and normal green stem. Later the enlarged spots turn brown and may girdle the lower main stem or involve nearly all the stems of the plant.

A badly infected crop appears dirty brown and "ripens" when bolls are only partially filled.

Control: The pasmo fungus, like that of rust, overwinters on straw and stubble and in trash in the seed. The control measures applicable to rust tend to control pasmo also.

The Golden varieties are extremely susceptible, among them Viking. Bison is not so badly infected early in the season and Redwing approaches Bison in this respect.

3. Wilt

Flax wilt no longer exists as a plant disease problem in South Dakota. Wilt-resistant varieties of flax (Redwing, Bison) are commonly grown. In some few instances, the idea that "flax is hard on the land" may still persist. This notion, of course, is an outgrowth of the fact that when wilt-susceptible flax is grown for several years on the same field, the soil becomes so infested with the flax wilt fungus that the crop fails because of wilt.

CORN

1. Seed Rot and Seedling Blight

Much of South Dakota's 1942 corn crop was "soft" and moldy. Much slightly immature and somewhat moldy seed may be planted in 1943. Sometimes seed from nearly healthy-appearing ears is inconspicuously infected or covered with fungi (molds) which may rot the seed or the roots of seedlings from such seed. Such infected seedlings may die, but more often are "blighted" or stunted. Apparent recovery is deceiving, for the life-long capacity of a corn plant is limited by its development during the first six weeks of growth. If cold wet weather prevails after planting, seed rot and seedling blight may result from the infection of disease-free seed by soil-borne fungi, particularly if the seed is weak, as much of it may be for 1943.

Control: Treat all seed before planting with New Improved Semesan Jr., Barbak C or Merko, 1 1/2 or 2 oz. per bushel. Spergon, which contains a new non-metallic toxic ingredient, has recently been offered for sale. It has proven satisfactory at Brookings.

Corn seed treatment also helps insure a stand from slightly diseased seed or even disease-free seed in cold wet soil. Seed treatment may not increase the stand or yield from vigorous disease-free seed which germinates in warm soil, but the stand insurance provided by seed treatment in South Dakota will be well worth the cost. The amount of mercury applied to a bushel of corn seed is small; there is little waste even if the insurance was not needed.

2. Other corn diseases such as smut, stalk rot, ear rot, rust, etc., occur in South Dakota, but no simple reliable control measures are available.

SORGHUM

1. Smut

Sorghum smut is the black sooty degeneration of all the kernels of the ear. The individual black spore masses are a bit longer than the normal kernel and may be temporarily covered by a white or gray membrane which ruptures finally in harvesting, if not before, so that the tiny black spores are caused to scatter and some to be deposited on the surface of normal kernels. There they remain to germinate with the seed the following spring and infect all parts of the growing plant. Black spore masses displace the kernels of all ears on plants thus infected.

Control: Kill the spores adhering to the seed by treating before planting with copper carbonate, 3 oz. per bushel, well agitated with the seed to assure uniform coverage. Organic mercury dusts such as New Improved Ceresan or New Improved Semesan Jr., will also give control at the rates recommended for small grain or corn, depending on the material selected. Seed treatment also helps insure a uniform stand of healthy, vigorous plants.

2. "Milo" Disease

"Milo" disease constitutes a failure of grain sorghum where amber forage sorghums succeed. Grain sorghum stands which start to "burn" when 12 to 15 inches high and fail to head normally despite thin planting and a fair moisture supply may be afflicted with the "Milo" disease, especially if amber forage varieties on the same field or under similar conditions are normal. This disease is probably not yet common in South Dakota. Knowledge of its presence or absence would be particularly useful at the Agricultural Experiment Station at Brookings.

Control: Over-cropping to sorghum contributes to a "pollution" of the soil with this disease in Kansas. Resistant strains have been selected but seed of such may be hard to buy. Above all, report grain sorghum failures in the vicinity of amber sorghum successes to the county agent or the plant pathologist, South Dakota Agricultural Experiment Station, Brookings. There is reason to believe, but yet no proof, that "Milo" disease occurs in some South Dakota grain sorghum fields. Definite knowledge of its presence or absence in the state is highly desirable, since it is perhaps the most destructive known sorghum disease. It is not brought in on seed and can not be controlled by seed treatment.

3. Sorghum is also afflicted with "weak neck" and "charcoal rot", but their occurrence in South Dakota has not been determined and their control is not known.

Vegetable and Fruit Disease Control Suggestions for 1943

Plant diseases became one of the distressing items in home production of vegetables and fruits in 1942. Loss of leaves of tomato plants, with disappointing yields and poor quality fruit as a result, premature dying of potato vines with a likewise disappointing yield and subsequent rotting of tubers in storage, wilting of peas and cucumbers and "blight" of carrots and celery were common occurrences in South Dakota vegetable gardens in 1942. Twigs of apple trees blighted with an obviously abundant moisture supply, the fruit was misshapen and spotted as a result of apple scab; cherries lost their leaves, gooseberries lost their leaves, so did strawberries. The leaves of grapes in some instances downy mildewed and even lilacs and blue grass had more than the usual amount of powdery mildew. Blue grass in spots and some rose bushes were rusted like small grain.

These and other plant diseases occur regularly in South Dakota. In fact their depradation has in some instances been attributed to the dry weather which sometimes also prevails! Ironically, many plant diseases have a tendency to become worse with abundant moisture and humidity and moderate temperature, the very conditions under which we rightfully expect plants to do well also.

During 1943, South Dakota home gardens must not fail for any avoidable reason, among them plant diseases. Most home gardeners are probably not in a position to undertake intensive control measures adequate to achieve the nearly perfect product necessary in commercial gardening. But they are probably anxious, under the circumstances, to attempt simple procedures which give assurance of a satisfactory crop of reasonable quality. The suggestions herein are based on that assumption, and while applicable to the commercial gardener, may not be adequate for his situation.

One more item by way of introduction: New supplies of dust and spray materials containing copper, mercury, zinc and formaldehyde may be scarce or non-available. The slogan in that regard should probably be, "Use them when needed, adequately, carefully, not wastefully".

General plant disease control practices

SANITATION AND ROTATION

A sound basic assumption is that the bacteria and fungi ("germs", molds) which cause plant disease overwinter with portions of diseased crops, or in soil on which the crops were grown. It is therefore sound to attempt some kind of elimination or avoidance of overwintered diseased seed or seed stock, plant tops, roots and infested soil.

Diseased plant remains may be burned or plowed under in the fall or in the early spring, depending on their value as organic matter or in holding snow and soil in a particular garden. In order to make crop rotation effective they are best turned under in the place where they grew.

Where there is only one garden site it is usually possible to so plan the garden as to not have a given crop on the same soil area more than once in three years. With more than one garden site, certain vegetables may be grown successfully and conveniently on either site, thus lengthening the interval between identical crops on a given area. More than a five-year "rotation" is probably not necessary.

Seed or propagation stocks sometimes harbor plant pathogens. In this respect,

the home-grown supplies, particularly of seeds, are probably on the average less desirable than those made available on the market by reputable seed distributors.

SEED DISINFECTION AND PROTECTION

Certain chemicals may be applied to the seed to reduce the likelihood of infection of the germinating seed and seedling by the disease-producing organisms carried in or on the seed. Such "seed treatment" tends in many cases to improve seedling stands and vigor also by protecting the germinating seed and seedling from infection by seed, seedling and root-rotting organisms in the soil. Very seldom does seed treatment spell the difference between success and failure of a vegetable crop. But it is stand insurance and is so inexpensive that even very small, almost indiscernible benefits repay the cost of materials many times over.

Beet, carrot, celery, corn, cucumber, eggplant, muskmelon, peas, pepper, pumpkin, spinach, squash, swiss chard, tomato and watermelon seeds respond most favorably to treatment with red or yellow copper oxide (Cuprocide) or organic mercury (Semesan) dusts. Broccoli, brussels sprouts, cabbage, cauliflower, chinese cabbage, collards, kale, kohlrabi, radish and turnip seed may be injured by copper (Cuprocide). Special organic mercury compounds are standard for potatoes (Semesan Bel) and corn (Barbak, New Improved Semesan Jr.). Manufacturers' directions accompany each package. In general, apply just enough to coat the seed.

STORAGE ROT PREVENTION

The following contribute most frequently to spoilage of fresh vegetables in storage: 1) wounds, 2) excessive or too little moisture, 3) high temperature, 4) freezing and 5) specific spoilage diseases as of potato. In the light of these principles, the following suggestions for preventing storage rots are in order: 1) Dig or otherwise harvest plants without wounding, when the soil is dry, and separate wounded portions for immediate use. 2) Store in a basement room which can be eventually kept between 35 and 40 degrees. It is not necessary, may even be better not to have the temperature that low immediately. Wound healing occurs at moderate temperatures in the presence of some moisture. 3) When packing vegetables in sand, the sand may be slightly moist, not wet nor dry. The same holds for soil, which may be sometimes used as successfully as sand. Once vegetables are packed, they are best left undisturbed in any way.

Potatoes are one special case. They may well be sorted once or twice during the storage season, provided they are handled very carefully. They need not be packed in sand or soil.

Specific diseases of South Dakota Garden Crops

TOMATO DISEASES

1. Alternaria leaf spot and early blight

This disease is caused by a fungus (mold) which infects seedlings to bring about "collar rot" and later the lower leaves to bring about a brown irregular spot with concentric rings of ridges, resulting in a target-like appearance. The lower leaves may finally turn yellow and drop off, exposing the innermost fruits to sunscald. Fruit infection may occur through cracks and wounds. Circular dark brown or black sunken spots are found which become covered with black velvety growth. This disease is commonly present on tomato seedlings grown in infested greenhouse or hotbed soil. It may also overwinter in soil or on infected tops in the garden. Its spread is usually checked by hot weather, particularly hot dry weather. It is seldom extremely serious in the home garden where highest quality is not necessary.

Control: Purchase disease-free seedlings grown in clean soil by a reputable local grower or produce them at home in "tomato-clean" soil, from seed treated with Cuprocide or Semesan. Soil baked in the oven for one hour at 300 degrees is sure to be "clean".

2. Septoria leaf spot

This is a very serious disease caused by a fungus which produces uniformly small grey spots with a black border. Finally the spots enlarge slightly and small black specks form at their centers. The lower leaves become heavily spotted first, but spread is rapid to higher leaves and succulent stems. Heavily spotted leaves turn yellow and fall off progressively from the bottom to the top of the plant. Such defoliation results in sun-scalded, prematurely ripened fruits. This disease is carried over winter in old tomato tops.

Control: Rigid removal or plowing under of old tomato tops and rotation of the tomato patch in the garden and between garden sites are essential. Once some leaves are infected, usually about July 1 to 15, to achieve control the plants must be sprayed at least twice, perhaps three times, at biweekly intervals with Bordeaux mixture as per directions on the carton. Purchase or home production of disease-free seedlings grown in clean soil is again desirable. The Bounty variety is severely affected by this disease.

3. Fusarium wilt

If tomato plants are wilted, yellow, and stunted, without the presence of leaf spots, and the lower portion of the stems brown internally, they are afflicted with Fusarium wilt. The plants are doomed. They may not die for some time, some may not die at all, but all will remain unthrifty and unproductive.

Control: Cure is impossible. Prevention is by purchase or home production of disease free seedlings grown from treated seed in clean soil and by not planting tomatoes again for at least three years, five preferably, on soil that has harbored wilted plants. Victor is a somewhat resistant variety and suitable for South Dakota. Other wilt-resistant varieties, such as Marglobe, Pritchard and Pan American are too late for most of South Dakota.

4. Still other tomato diseases may result in spotting or decay of the fruit. Their control, as much as is feasible, is essentially the same as for the leaf spots, namely, clean culture in production of transplants, removal or plowing under of old tops, rotation, and spraying if necessary.

POTATO DISEASES

1. Late blight.

The late blight fungus causes a rapid browning and death of leaves and small stems during periods of abundant moisture, constant humidity and moderate temperature. Less than one week of warm, dry weather in August [illegible] temporarily stopped this disease at Brookings in 1942. It apparently had made an unnoticed start in South Dakota in 1941 and spread rapidly with the favorable weather this past season. The distinguishing character of late blight is the downy mildew on generally the under surface of the leaf at the advancing edge of the killed area. This down contains the spores or "seeds" of the fungus, which are its means of spread and supposedly are capable of washing into the soil and there infecting the tubers. Presumably these spores may also infect tubers in storage, provided the tubers are dug during damp weather when the spores are present. At any rate, tubers or infected vines may somehow become infected; and in them the fungus overwinters. No other means of overwintering are known. Badly infected tubers may dry rot in storage. When infected tubers are planted and resume growth, the late blight pathogen grows with and into the developing sprouts. The beginnings of an outbreak are thereby established; spread depends on continuously moderate wet weather with a minimum of sunshine.

Control: This is indeed a serious disease and its general occurrence throughout all but the Rocky Mountain area of the northern half of the United States has caused considerable concern among potato growers, particularly southern growers who normally purchase northern-grown seed stocks. Two items are in the South Dakota potato grower's favor. Late blight was not as bad here as in states to the east, and the chances are very good that hot dry weather will stop the disease. This is the first known occurrence of the disease in South Dakota.

The grower could spray, but unavailability of equipment and materials and his own inexperience are against his achieving first rate control. If he normally sprays with Bordeaux mixture for leaf-hopper control, then an extra spray and a little more care to achieve uniform coverage on both leaf surfaces would certainly be worth while. Dusting in general is not effective, except by a grower who has excellent equipment and is willing to apply dust thoroughly to plants when the foliage is wet.

Planting non-infected seed is the most feasible control. If seed potatoes are bought, then certified seed stock, particularly South Dakota-grown, is more likely to be "blight-free" than uncertified stock. If seed stock is available from an early patch of potatoes known to be blight free and not more than two years "removed from certification", it may be as satisfactory as some certified stocks. In either case, it is well to sort the potatoes very carefully not long before planting. Infected tubers are so likely to be surface dry rotted before spring that they can almost surely be sorted out just before planting. Sorting is just as important with certified as with other seed stocks. Certification standards require a tuber examination for late blight infection at time of storage. This is a worthwhile precaution, but does not absolutely insure freedom from late blight infection if the vines were at all blighted.

2. Scab

This disease is characterized by the rough "scabby" surface so common on garden-grown potatoes. The causal agent overwinters on the tubers and in the soil.

Control: Seed tuber treatment will kill the overwintering scab on the tubers. An organic mercury compound sold in drug stores under the trade name, "Semesan Bel" is a very convenient treatment for the home gardener. Directions are on the container. Hot formaldehyde or mercuric chloride are more effective and economical for the commercial grower. Detailed directions are not included here, but may be obtained from the county extension agent or the Agricultural Experiment Station at Brookings.

3. Black scurf

"Dirt that won't wash off" on an otherwise clean, smooth tuber is the best description of this disease. When a tuber with such "dirt" on it is planted and starts to grow, the "dirt" grows also, infects and kills the outside of the stem of the growing shoot just above the tuber. A brown area which sometimes encircles the stem and invariably stunts the plant is the result.

Control: Seed tuber treatment will kill the "dirt" on the tubers and largely prevent stem infections. See scab control for suggested treatment.

4. Blackleg

Blackleg is a dark soft rot of the stem just above the tuber and of the tuber itself. It occurs on potatoes in water-logged soil, particularly in low, poorly drained areas. Presumably the causal agent overwinters on the seed tubers.

Control: Clean seed stocks and seed tuber treatment. See scab control for suggested treatments. However, even when treated seed pieces are planted, some blackleg is likely to occur on potatoes in areas of very wet soil.

5. Spindle tuber, mosaic and other "virus" diseases

This group of diseases, whose causal agents are mysterious, unobservable entities within the "living stuff" of the potato, result in dwarfing, curling, crinkling, mottling and stiffening of the potato tops. A general unthrifty condition of the plant prevails which is conducive to low yields. The grower says his seed stocks "run out". Actually they are afflicted with disease, usually of this type.

Control: Clean seed stocks are the only feasible control for the home gardener and small grower. Very few have the time or the experience necessary to eliminate diseased plants in the field in time to prevent spread to healthy plants. One of the dependable, prime attributes of certified seed stocks is freedom from virus diseases.

6. Fusarium wilt

As the name signifies, wilting is the chief symptom of this disease, usually by mid-summer. Internal browning of the stem and tubers are associated with the wilting. Carried-over infected tubers are the principal source of the disease. The fungus persists in soil also.

Control: Tuber stocks containing deeply discolored or rotted tubers are of doubtful value for planting, even if sorted. Certified seed stocks are usually free of such tubers.

7. Bacterial wilt and ring rot

Plants afflicted with this disease turn yellow and wilt in late summer. There

is very little internal stem browning and the tuber discoloration is creamy white, crumbly and in a ring 1/4 to 3/4 inches beneath the surface of the potato. In such slightly rotted potatoes is the only known means of carrying the disease from year to year.

Control: This disease is beyond the resources and experience of the home gardener and perhaps even the commercial table stock grower to control. Purchase of certified seed stocks is the only means of control at their command. Even certified seed stock producers make no effort to keep a lot of seed containing tubers afflicted with this disease.

PEA ROOT ROT AND WILT

Peas sometimes become unthrifty at about flowering time. An examination of the roots often reveals distinct browning which sometimes extends up and into the stem.

Control: The nature of this trouble is not too well understood, but peas are one of the crops most likely to respond favorably to seed treatment, and the sprinkling of a very small amount of phosphate fertilizer in the row with peas often improves their root health and general vigor.

CABBAGE WILT OR YELLOWS

A pronounced wilting and yellowing of the leaves on one side of the plant is characteristic of this disease. Internal browning of the stem on the wilted side is also conspicuous. Such a condition results from plugging of the water tubes of the plant on that side by the causal agent, which is soil-borne for sometimes five years or more.

Control: Rotation within and between garden sites will ordinarily prevent this disease. (See general control measures.) Once present, its elimination may require too long a rotation to be practical. In that case, the Golden Acre, Jersey Queen, Marion Market, and Wisconsin Ballhead varieties of cabbage are resistant and suitable for South Dakota.

CUCURBIT WILT

Individual cucumber, muskmelon and squash vines sometimes wilt and die within two or three days after appearing to be quite normal. One by one they wilt and die, sometimes until nearly all the plants of a stand are gone. If the stem of such plants is pulled up and broken near the ground line, the sap often is stringy where the two broken portions are separated.

It is well known that the bacterium which plugs the water tubes in the vine is carried over winter within the body of the cucumber beetle. Infection occurs most freely when the awakened beetles are feeding on young plants usually some time in late May or June. About a month later the result of such infection becomes evident.

Control: Roguing of plants that are wilting will help so little that it is almost useless. Absolute control of beetles from the time they first appear is necessary to surely prevent infection. To be sure of beetle control, seedlings must be covered with 5 percent rotenone dust from the time they break through the ground until they begin to vine.

CARROT AND CELERY "BLIGHT"

The leaves of carrots and celery sometimes turn brown after mid-summer. With carrots, to a certain extent celery, the effects appear to be temporary because of subsequent formation of more leaves. Although coincident with hot dry weather, this "blighting" is in fact a killing of the leaf by plant disease fungi, a specific one for each of the two crops. They overwinter on dead infected tops and seem to thrive in rather warm, wet weather, although certainly a few dry days does not stop them as it does the potato late blight fungus. Spread is fairly rapid during warm weather but seems to stop when cooler fall weather approaches.

Control: Sanitation and rotation usually keep these diseases down to a non-harmful level. Should they become established, spraying of the carrot and celery tops whenever tomatoes or potatoes are sprayed with Bordeaux mixture should be a satisfactory and convenient control.

Serious South Dakota Fruit Crop Diseases

Fruit growing is not an extensive commercial enterprise in South Dakota. With a few noted exceptions, fruit diseases usually are not alarmingly serious and when present, they affect the quality rather than the quantity of the crop. In 1942, several fruit diseases became very conspicuous, notably scab and fire blight of apple, and strawberry leaf spot. Even so, fungicide applications are expensive; some contain metals vital to defense. Efforts at fruit disease control by the home orchardist in South Dakota might well aim to accomplish all that is possible by sanitation practices, supplemented where necessary by a minimum of timely, well applied spraying.

APPLES

1. Scab

Apple scab occurs as velvety olive brown to black webby spots on the leaves, flowers and fruits, rarely on twigs. The causal fungus destroys the normal waxy covering. The tissues underneath dry out and subnormal growth of the spot area may result in distortion of the infected fruit or leaf.

The causal fungus over-winters on infected fallen leaves, from which spores are discharged and borne to opening apple buds in the spring, where the unfolding leaves and flowers are subject to infection. The first spots thus formed bear still other spores which may find their way to new unfolding leaves or small fruits.

Control: Since the fungus over-winters primarily on dead leaves, the thorough destruction of fallen infected apple leaves is the basis for control in the farm orchard. In South Dakota, apple scab is not of sufficient importance to warrant a spray schedule just for apple scab control. However, should the grower apply a calyx spray for codling moth, the addition of Bordeaux mixture, as per directions on the carton, to the insecticide mixture would be desirable in eastern South Dakota.

2. Blotch

Apple blotch is manifested as irregular brown spots on the fruit, small yellow to light brown spots on the leaves, or as purple to brown cankers on small twigs. Severely infected fruit may crack and twigs may sometimes be girdled and killed. A large percentage of infected fruit drops prematurely.

The causal fungus over-winters primarily in the twig cankers. In late spring, spores which ooze from infected cankers find their way to fruits, leaves and twigs where they germinate and the resulting fungus growth enters the immediately underlying tissues. Further development and spread depends upon warm damp weather.

Control: Since the fungus over-winters primarily in twig cankers, the removal by pruning of all killed or cankered twigs eliminates a large portion of the over-wintering source of the pathogen. The severity of blotch in South Dakota is not sufficient to warrant spraying for blotch alone. However, if a codling moth spray is applied in June, the addition of Bordeaux mixture as per directions on the carton to the insecticide mixture would be desirable in eastern South Dakota.

3. Rust

Rust occurs on apple leaves and small twigs as yellow to orange swollen spots with black pimples in their centers usually on the upper leaf surface and stellate projections on the lower leaf surface. On the red cedar, which is an alternate host. it occurs as green to reddish brown galls two inches or less in diameter.

In May, rust spore masses ooze from the galls on the red cedar and find their way to apple leaves and small twigs. There they germinate and the resulting fungus growth enters the tissues underneath. The developing spot first forms the ultimately black pimples on the upper leaf surface, later the stellate protrusions on the lower leaf surface. From the centers of these protrusions, spores are shed and carried by wind to the red cedar, where they germinate. The resulting fungus growth invades underlying tissues and the formation of galls is under way.

The apple rust fungus persists over winter only in the galls on red cedar. Apple rust occurs freely only where red cedars and apples grow side by side, within ¼ mile.

Control: Either cedars or apples must be removed from the association. In one case in southeastern South Dakota, both cedars and apples were suffering from this disease. Diligent repeated picking by April 1 of all cedar galls is possible but not very feasible means of control. It is useless to spray after the yellow spots are visible on apple leaves; at that time no further spread occurs. If spraying is attempted, all leaves must be kept covered (with Bordeaux mixture) from the time the buds open until at least June 1, preferably until June 15.

4. Fire Blight

This disease is prevalent in the Spearfish valley and has recently occurred in northeastern South Dakota. It is not likely to be serious in South Dakota generally. As the name indicates, it is characterized by a general dying of afflicted parts as if from fire. Blossoms, spurs, leaves or twigs may become limp and blackened. Drying later completes the "blight". Leaves remain on blighted twigs throughout the following winter. Sunken cankers remain where the disease has progressed down a twig to the point of origin from a branch.

In the edge of such cankers the causal bacterium lives over until tree growth is resumed. As the sap flows, the sweet ooze from infected cankers is heavily laden with the deadly "germs." Insects and wind and rain can carry such ooze to growing blossoms, spurs, leaves and twigs where the tiny "germs" enter through natural openings or slight wounds and proceed with the decay of invaded tissues.

Control: Anything conducive to excessively rapid growth favors fire blight development. Excessive irrigation, manuring, cultivation, fertilizing with nitrogen, all are favorable to the development of the disease. Close spacing is conducive to spindly, susceptible growth and retards air drainage and subsequent elimination of humid atmosphere and dew, all of which are favorable to the disease.

Prevention lies with the removal of all infected holdover twigs and cankers at a point unquestionably below the edge of the infected region. Careful examination and fastidious pruning are essential. A careless superficial job is quite useless. The pruning knife should frequently be dipped in formaldehyde, 1-15, or 50-75 percent alcohol.

STONE FRUITS (plums, cherries, sand cherries)

The stone fruits are likely to be badly diseased almost anywhere in South Dakota. All are afflicted with one or more of the three diseases which are subsequently discussed: brown rot, "pockets" and yellow-leaf.

1. Brown rot.

This disease affects plums and sand cherries, sometimes cherries to a limited extent. It is a chocolate-brown rot of the nearly mature fruits, primarily, but blossoms and twigs may become blighted and small branches may develop brown rot cankers. The latter usually develop on a branch at the base of an infected twig or spur. After several days duration, the centers of diseased areas are covered with ashen gray tufts of spores of the causal fungus, frequently in concentric rings on the fruit.

Infected fruits are eventually entirely rotted, either on or off the tree. They soon shrivel and dry up and often cling for some time to the tree. They may adhere to similar adjacent fruits. Such rotted, dried fruits are called "mummies". In the spring the causal fungus first develops on and spreads by spores from mummies and branch cankers to flowers and growing twigs. The first rotted petals or twigs are a basis for spread to others by means of the tufted spores which are almost invariably formed. Thus when fruit is approaching the mature susceptible state, the disease is already established on twigs. Fruit infections occur through wounds, chiefly those made by the plum curculio.

Control: The removal and destruction of mummies on the tree and on the ground and pruning out of all cankerous branches serve to reduce the bases of early spring spread of the causal fungus. A dormant spray with lime sulfur as applied for "pockets" will help control brown rot. Likewise will another spray with Bordeaux mixture, applied as per directions on the carton about a month before the plum and sand cherry fruits ripen.

It is principally through wounds made by the plum curculio that the brown rot fungus gains entrance, particularly into fruits. The addition of lead arsenate as per directions on the carton to the pre-ripe Bordeaux spray will aid in curculio elimination. The timely harvest of all ripe fruit and immediate destruction of all undesirable fallen fruit will do away with many curculio larvae before they mature.

2. "Pockets"

This is a disease primarily of plums and sand cherries in South Dakota. On the latter it is the cause for more inquiry than any other single South Dakota fruit disease. It is characterized by enlarged, bladderlike elongated fruits and enlarged, reddish-colored and finally decayed leaves and growing twigs. It is caused by a fungus whose spores live over winter on the bud scales. Infection takes place as the buds swell and begin to grow. There is no further spread during the season.

Control: Control consists in eliminating the spores in the bud scales before the buds swell with a dormant spray, in either the fall or early spring. Spray every bud; those missed will probably show the disease. Later sprays are of no avail in controlling "pockets". Lime sulfur may be used, diluted 1-15 with water; apply with some sort of pressure sprayer to get uniform coverage with a fine mist spray.

3. Leaf blight or yellow-leaf

This is a disease primarily of cherries, but sand cherries and plums are also mildly affected. The striking symptoms are a spotting, yellowing, and final falling of the leaves, usually about the time the fruit matures. The fruit is not affected. Damage results from the weakening of the tree by defoliation while the next season's fruit buds are setting and the tree is "hardening" for winter. The short life of cherry trees is doubtless in part a result of this disease.

The causal fungus over-winters on fallen infected leaves and in the spring spreads from them to the new leaves, from which further spread can occur.

Control: Destruction of the fallen leaves plus protection of the new leaves by a minimum of two sprays with Bordeaux mixture as per directions on the carton should adequately control this disease in South Dakota. The first spray should come after the cherries are well set, the second immediately after the cherry crop has been harvested. The single brown rot spray for plums and sand cherries about a month before the fruit ripens should suffice to also control yellow leaf, since plums and sand cherries are not as susceptible as cherries, particularly sweet cherries.

RASPBERRIES

Anthracnose or "gray bark" and leaf spot (all one disease) may occur in some South Dakota gardens, but is probably not serious except in the southeastern part of the state. It is characterized by first purple, later gray, merging spots, finally with pits at their centers, on the current season's canes. The next season, serious cracking with subsequent excessive water loss reduces the yield from such infected canes.

The fungus spreads by spores formed in the spring on one-year-old (bearing) canes or on over-wintered leaves if they were infected. Spread and infection occurs first at about the time the buds are starting to grow and continues throughout the season during warm, damp weather.

Control: The disease is primarily one of old patches. If new plants are clean when set out the disease usually does not develop for 3 or 4 years. New plants should be bought from a careful, reputable nurseryman whose stock undergoes careful inspection for disease.

Removal of dead leaves and dead canes (previous season's bearers) will help

some. If present, however, the disease can be properly controlled only by spraying. Lime sulfur 1-15, applied as the buds are swelling, is the most important spray and should be the only one needed in South Dakota.

STRAWBERRIES

1. Foliage diseases.

Several leaf spots of strawberries are known and may occur to a limited extent in South Dakota. They are probably not serious enough to warrant the use of spray materials at this time. They are primarily diseases of old beds. Setting out vigorous plants in a new bed every 3 or 4 years in a different area in the garden should prevent unusual outbreaks of strawberry leaf diseases in South Dakota.

2. "Virus" diseases.

The causes of "yellows" and "crinkle" (severe) are inherent in the "juice" of the strawberry plant and are spread most freely by aphids. The only control is ruthless elimination of diseased plants in old beds and then exclusion from new beds.

Suggested Fruit Disease Control Program for South Dakota

	Apples	Stone Fruits			Raspberries	Strawberries
		Plums	Sand Cherries	Cherries		
Eradication (Sanitation)	Destroy over-wintered leaves infected with scab and blotch. Prune out blotch- and blight-infected twigs and cankers. Remove rust-spreading cedar or pick off all galls on cedars annually.	Prune out "pockets" infected twigs. Prune out all brown rot cankers. Remove and destroy all brown rot mummies from trees and ground underneath. Rake up and burn all over-wintered leaves (for yellow-leaf control).			Set out anthracnose-free plants from reputable nursery. Destroy dead canes, leaves.	Remove yellow, crinkled plants from old bed; omit from new bed. Start new bed every three or four years.
Protection	Bordeaux mixture added to codling moth insecticide as calyx spray (for scab) and in June (for blotch; scab if present).	Dormant lime-sulfur spray for "pockets" and brown rot. July Bordeaux spray for yellow-leaf. (This spray controls brown rot on fruits. Add lead arsenate for curculio elimination).		Fruit-set Bordeaux spray for yellow-leaf.	Delayed dormant lime-sulfur spray (for anthracnose).	
Culture	Avoid excessive irrigation cultivation, manuring, fertilizing; provide adequate tree space (for fire blight).					

Three Common South Dakota Tree Diseases

There doubtless are many more or less serious diseases of trees in South Dakota, but since 1940, three have frequently been encountered and therefore have been the subject of nemerous inquiries. They are cottonwodd leaf rust, ash rust and elm wilt.

COTTONWOOD LEAF RUST

This disease was so common and destructive in South Dakota in 1942 that many shelterbelt owners were concerned about their cottonwood plantings. In many instances, 95 percent or more of the leaves fell before frost. Considerable defoliation by this disease occurs nearly every year, with apparently little or no damage to the afflicted trees.

In the summer, golden yellow or orange powdery pustules (open spots) appear on the under surface of cottonwood leaves, first scattered, later so closely crowded that the entire surface seems powdery. This is the "red rust" stage, the spores of which may be spread and infect healthy leaves. In late summer and early fall, small slightly raised areas or crusts appear. At first orange-yellow in color, they change to dark brown or black. This is the "black rust" stage, in which the rust overwinters in fallen leaves, from which it may spread to its alternate host, if any. Actually, the alternate host of the cottonwood rust in South Dakota is not known. Furthermore, the cottonwood leaf rust fungus lives over winter in South Dakota in the "red rust" stage, so that an alternate host is not necessary. Spread is direct from overwintered leaves to green leaves.

Control: The severity of the disease depends upon the time of the first infections and subsequent humid weather, as in 1942. Development of the disease is favored by close planting, dense cover, low elevation--anything which tends toward a humid atmosphere around the leaves. The lower leaves usually fall first. Unnecessary delay in thinning and pruning of the shelterbelt promotes heavy infection.

Spraying bi-weekly with Bordeaux mixture might control the disease, but few owners would be equipped or willing to undertake it. Furthermore, only with the addition of a "spreader" such as casein would the spray adhere to cottonwood leaves, and then doubtless very poorly. Unless subsequent experience indicates more harm from this disease than has occurred in the past, spraying is probably not necessary.

ASH RUST

This disease occurs commonly on green ash in South Dakota and was more prevalent in 1940 and '41 than in '42. However, it causes frequent concern and is therefore described here. It is really a rust, which results in swellings on the twigs and petioles and distortion of the leaves. After the swellings form, they are covered with cluster cups, filled with a yellow powder. These cluster cups are almost identical to the stage of stem rust on barberry and oat crown rust on buckthorn. As with these rusts, the spores from the cluster cups on ash are spread by the wind and are capable of infecting grass plants, in this case marsh and cord grasses. On these there develops the usual red and black spore stages very comparable to stem rust on cereals. The black spores overwinter on the grass, germinate in the spring to release other spores, some of which find their way to ash leaves, infect them, and there produce again finally the cluster cup stage. There is no spread from ash to ash.

Control: No control is necessary. The failure to spread from ash to ash restricts the potential danger of this disease to ash. Sometimes the leaves of an

entire tree or group of trees may be heavily rusted without serious damage resulting. If a tree fancier insists on spraying, it should be with Bordeaux mixture early in June, after the leaves are well formed but before the rust spots appear. It is useless to spray after even the first sports are in evidence. No new infection on ash will occur after that time, although more undeveloped infections may form rust areas on leaves and twigs.

ELM WILT

The first symptoms of this disease are yellowing of the leaves usually preceding or sometimes accompanying drooping or wilting. The disease progresses rapidly upwards but slowly downwards in a stem. Finally the branch is killed. The wood shows a brown diffuse streaking just under the bark. Spread presumably is through wounds in the leaves, usually by insects.

Control: The only real control is to prune out infected branches of a prized specimen or better still, if there are several healthy trees in the area, remove the entire infected tree. In either case, infected wood should be burned immediately or cut up and put in the basement for fuel. When pruning is resorted to, at least two will be necessary, one in the spring and another in the summer, or the first in late summer and the second the following spring. Spraying is impractical and of doubtful value.

After the spring pruning, an application of 1 to 5 pounds of sodium nitrate on the soil area covered by a 3 to 6 ft. circle around the base of the tree (both items depending on the size of the tree), may stimulate the tree to "outgrow" the disease. Daily heavy watering for at least a month should follow such a fertilizer application.

Sometimes leaky gas mains, sewers or extreme lack of moisture brings about an unthrifty condition in elms. These conditions usually cause no immediate wood discoloration and their effects should not be attributed to a diseased condition of the tree.